

1                   **VARISTOR AND FABRICATING METHOD OF**  
2                   **ZINC PHOSPHATE INSULATION FOR THE SAME**

3    BACKGROUND OF THE INVENTION

4    1. Field of the Invention

5           The present invention relates to a method of fabricating a varistor with zinc  
6 phosphate insulation and the varistor fabricated by the method, and more particularly to  
7 a fabricating method that provides flat insulation on outer surfaces of the varistor.

8    2. Description of Related Art

9           The prior art discloses a method of fabricating the insulation for a varistor. The  
10 varistor has two end terminals and a ceramic body with an outer surface. The method  
11 uses a chemical reaction between a phosphoric acid and the surface of the ceramic body  
12 to form zinc phosphate insulation on the ceramic body. The zinc phosphate insulation  
13 isolates the surface of the ceramic body and the electrolyte, but the zinc phosphate  
14 insulation reacts chemically with the ceramic body, so that the body is etched and has a  
15 rough surface. A metal material used to coat the end terminals is inadvertently  
16 electroplated on the insulation.

17          Therefore, another method of fabricating the insulation to overcome the  
18 problems was developed. The fabricating method uses zinc phosphate deposits on the  
19 surface of the ceramic body to keep from etching the surface. Therefore the surface of  
20 the body is kept flat, but the insulation layer is still rough. However, metal material is  
21 still electroplated on the zinc phosphate and the yield is not good. Therefore this  
22 fabricating method does not solve all of the problems.

23          Therefore, an objective of the present invention is to provide an improved  
24 method for fabricating zinc phosphate insulation for a varistor to mitigate and/or obviate

1 the aforementioned problems.

## 2 SUMMARY OF THE INVENTION

3 The main objective of the present invention is to provide a method of fabricating  
4 a varistor with zinc phosphate insulation that fabricates a flat surface on the varistor and  
5 does not deposit any metal material on the surface and a varistor fabricated by the  
6 method.

7 Other objects, advantages and novel features of the invention will become more  
8 apparent from the following detailed description when taken in conjunction with the  
9 accompanying drawings.

## 10 BRIEF DESCRIPTION OF THE DRAWINGS

11 Figs. 1A to 1D are cross sectional side plan views of the first embodiment of an  
12 apparatus in accordance with the present invention;

13 Figs. 2A to 2E are cross sectional side plan views of the second embodiment of  
14 an apparatus in accordance with the present invention;

15 Figs. 3A to 3F are cross sectional side plan views of the third embodiment of an  
16 apparatus in accordance with the present invention; and

17 Figs. 4A to 4E are cross sectional side plan views of the fourth embodiment of  
18 an apparatus in accordance with the present invention.

## 19 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20 With reference to Fig. 1A, a semi-finished varistor has a body (10) and two  
21 outer terminals (14). The body (10) has two opposite ends (101,102), multiple internal  
22 electrodes (13) and zinc oxide semiconductor filler (12) covering all of the internal  
23 electrodes (13). The two outer terminals (14) are formed on two opposite ends (101,102)  
24 of the body (10) and cover the two ends (101, 102) of the body (10). Each outer terminal

1 (14) has an outer face electrically connected to the internal electrodes (13) in the body  
2 (10). Each internal electrode (13) is directly connected to only one of the outer terminals  
3 (14).

4 The body further has an exposed surface (11) that is not covered by the outer  
5 terminals (14). The zinc oxide semiconductor filler (13) is fabricated using the HTCC  
6 process with additives, such as manganese oxide, nickel oxide, cobalt oxide, etc. metal  
7 oxide materials. The raw metal oxide materials can be fabricated from an organic salt or  
8 inorganic salt, such as carbonate or oxalate. The outer terminals (14) can be made of  
9 silver or a metal compound consisting of silver, platinum or palladium with frit. The  
10 outer terminals (14) can be fabricated with a printing method, a rolling method, a  
11 spraying method, etc. Further, the form of the body (10) can be a rectangle, cylinder,  
12 hollow cylinder, etc.

13 With reference to Figs. 1A to 1D, a method of fabricating zinc phosphate  
14 insulation for a varistor in accordance with the present invention has multiple steps. The  
15 method is used to complete the manufacturing process for a varistor (20a) and comprises  
16 the steps of applying the phosphate compound (15) to the exposed surface (11) of the  
17 body (10), heating the phosphate compound (15) until the phosphate compound (15)  
18 turns to a transparent insulation (16) and applying metal materials having at least one  
19 base layer (141) and at least one solder layer (142) on the outer surface of the outer  
20 terminals (14) of the body (10). In the first embodiment of the present invention there is  
21 one base layer (141) and one solder layer (142) formed on the outer surface of each outer  
22 terminal (14).

23 When applying the phosphate compound, an over-saturated phosphate liquor is  
24 kept at a high temperature to deposit the phosphate compound on the exposed surface.

1 The over-saturated phosphate liquor consists of phosphate ions, zinc ions, inorganic  
2 ions and metal ions.

3 The cured transparent insulation (16) has an anti-etch characteristic when in  
4 contact with an electrolyte (not shown) used in an electroplating process, to keep the  
5 exposed surface (11) of the body (10) smooth and from being electroplated. The outer  
6 terminals (14) are not covered by the insulation (16) so the base layer (141) is applied  
7 directly to the terminals (14). The solder layer (142) is subsequently applied to the base  
8 layer (141).

9 The step of applying the base layer (141) and the solder layer (142) to the outer  
10 terminals (14) can consist of electroplating, electroless plating, spray plating, rolling  
11 plating processes or barrel electroplating. An example of the applying step to form the  
12 base layer (141) and the solder layer (142) first uses the barrel electroplating process at 7  
13 amperes for 80 minutes to deposit copper or nickel on an outer face of the outer terminal  
14 as the base layer (141). A second electroplating process forms the solder layer (142) on  
15 the base layer (141).

16 The insulation (16) on the exposed surface (11) of the body (10) prevents the  
17 exposed surface (11) from being etched by the electrolyte (not shown) and metal  
18 material from being deposited on the exposed surface (11) during the electroplating  
19 process. Consequently, the body (10) remains flat and smooth and has no metal  
20 deposited on the surface (11) of the body (10).

21 With reference to Figs. 2A to 2E, a second embodiment of the method in  
22 accordance with the present invention further comprises a removing insulation step after  
23 the applying the base layer (141) and the solder layer (142) step to expose the surface  
24 (11) of the body (10). Therefore, the body (10) of the varistor (20b) has a flat surface (11)

1 and two opposite outer terminals (14) with the base layer (141) and the solder layer  
2 (142).

3 With reference to Fig. 3A to 3F, a third embodiment of the method in  
4 accordance with the present invention further comprises an applying protective coating  
5 step after removing the insulation layer shown in Fig. 2E. The protective coating (17)  
6 can be an organic material, such as acrylic polymer, polyester, epoxy polymer, etc.,  
7 coating the surface (11) of the body (10). Therefore, the varistor (20c) has a body (10),  
8 two outer terminals (14) with the base layer (141) and the solder layer (142) and a  
9 protective coating (17) formed on the exposed surface (11) of the body (10).

10 With reference to Figs. 4A to 4E, a fourth embodiment of the method in  
11 accordance with the present invention performs an applying protective coating step after  
12 the step that applies the base layer (141) and the solder layer (142) to the outer terminals  
13 (14). Therefore the varistor (20d) has a body (10), two outer terminals (14), insulation  
14 (16) and a protective coating (17).

15 As described, the method not only prevents the surface of the varistor from  
16 being etched by the electrolyte but also prevents metal material from being electroplated  
17 on the exposed surface of the body. Therefore the manufacturing process for varistors  
18 has a greater yield and the overall appearance of the completed product is improved.

19 It is to be understood, however, that even though numerous characteristics and  
20 advantages of the present invention have been set forth in the foregoing description,  
21 together with details of the structure and function of the invention, the disclosure is  
22 illustrative only, and changes may be made in detail, especially in matters of shape, size,  
23 and arrangement of parts within the principles of the invention to the full extent  
24 indicated by the broad general meaning of the terms in which the appended claims are

